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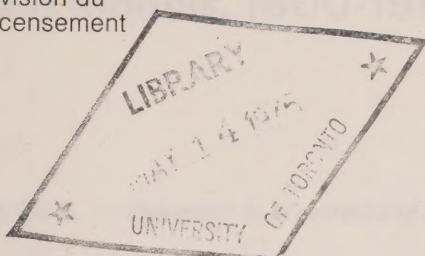
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POPULATION ESTIMATES FOR THE CANADIAN INDIANS
BASED ON STABLE POPULATION MODELS, 1900 - 1969

by

A. Romaniuc and V. Piché

PRINTED PUBLICATION No. 18

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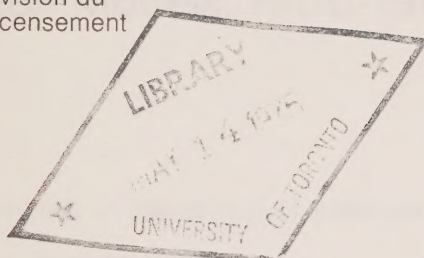
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Nativity Estimates for the Canadian Indians by Stable Population Models, 1900-1969

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V. PICHE / *Cornell University*

Après avoir démontré que les données officielles sur les taux de naissance de la population indienne avant 1960 sont largement inadéquates, les auteurs utilisent deux méthodes indirectes pour obtenir des estimés fiables de ces taux. La première méthode se sert des données disponibles sur la distribution de la population par classe d'âge depuis 1900 tandis que la seconde utilise les données du recensement de 1961 sur l'ensemble des naissances selon l'âge de la mère. On analyse dans les deux cas, les données sous-jacentes et on déduit les estimés, à partir de modèles qui postulent une population stable.

Les meilleurs estimés obtenus permettent de croire que le taux de natalité des Indiens est demeuré relativement stable dans le passé, au niveau de 50 naissances par 1,000 individus. On note cependant, un déclin constant de la fécondité depuis 1960. Ainsi le taux de natalité est passé de 46.0 pour 1000 en 1961 à 36.8 en 1969. Cette tendance peut être interprétée comme une évolution fondamentale dans la démographie de ce groupe ethnique.

After having shown that official series of birth rates for the Indian population prior to 1960 suffer from considerable deficiencies, two indirect methods are applied to arrive at some trustworthy estimates of these rates. Use is made, in the one case, of the age distribution data available since 1900, and, in the other case, of 1961 census data on children ever-born to women by age. In both instances stable population models are used for analysing the underlying data and for deriving the estimates.

According to the best obtained estimates, the birth-rate for the Indian population seems to have remained relatively stable in the past, at a level close to 50 per 1000 persons. A gradual decline in fertility has been taking place since about 1960. Thus the birth-rate has dropped from 46.0 in 1961 to 36.8 in 1969, the latest available figure. This trend may be regarded as a major development in the demography of this ethnic group which is, in many respects, unique in the Canadian context.

INTRODUCTION

There are about a quarter million Indians in Canada. A little more than 90 per cent of them live on the reserves in relative isolation from the main stream of Canadian life. They display demographic features which are much more similar to the populations of the developing countries than to the population with which they have had a century-long association. Due to progress in medical technology they have seen their mortality reduced to a low western

level, but their fertility still remains high, more than twice the level of the whole Canadian population. As a result of this high fertility the annual rate of natural increase presently lies in the vicinity of three per cent. At this rate the population would double every twenty-five years. The persistence of a relatively high fertility entails an age structure dominated by a large proportion of children and, hence, a high dependency ratio.

Notwithstanding the distinctiveness of their demography the group has attracted little attention from professional demographers. In particular, little is known about such an important topic as their fertility. It is hoped that, by ascertaining the level and the trends of natality, this paper will close some of the more conspicuous gaps in the knowledge of demography of the Indian people of Canada and lay the groundwork for investigations into their procreative behaviour.

Since the official series prior to 1960 are conspicuously defective, estimates of birth rate for this period have to be estimated by indirect procedures. Two procedures will be followed, one making use of the age distribution data available since 1900, the other of 1961 census data on children ever-born to women by age. In both cases stable population models are used as a tool to analyse the underlying statistical data and to derive the estimates of birth-rate.

INADEQUACY OF OFFICIAL BIRTH-RATE SERIES PRIOR TO 1960

The official birth-rate series prior to 1960 are characterized by unacceptable low levels and sudden jumps. Thus, for the registered Indians, the birth-rate, which remained relatively stable in the range of 20 to 25 throughout the years prior to 1940, jumped to 48 per 1000 in 1960. Similar inconsistencies with respect to the level and the trend are displayed by the series referring to the Indian population based on successive censuses. According to the latter the birth-rate was only 28.4 in 1931, and 33.2 in 1941, but rose to 52.8 in 1951 and 59.7 per 1000 in the 1961 census year.¹

Birth-rates as low as those observed in the past among the Canadian Indians are inconsistent with many observations that can be made with regard to the fertility patterns that are likely to have prevailed among this population. A high fertility rate for the Indians might be expected on the grounds that among them marriage is known to be quasi-universal, that birth control is unlikely to have been practised to any significant extent in

1 The term "registered" applies to those Indians (mostly on the reserves) defined as such by the Indian Act and placed under the direct jurisdiction of the Department of Indian Affairs and Northern Development. Population of Indian origin, as defined for census purposes, includes both persons of the former category and persons of Indian origin having the status of regular Canadian citizen. In 1961, for example, the latter group exceeded the former by some ten per cent. Whereas statistics on registered Indians are collected and published by the Department of Indian Affairs, statistics on the population of Indian origin are collected by Census and Vital Statistics.

those earlier years, and that there is no evidence of any considerable incidence of physiological sterility (Chenier, 1971). The prevalence of the high fertility level can be inferred also, as will be demonstrated more conclusively in the subsequent sections, from the data on the distribution of the Indian population by age. In view of the changing definitions of Indian population, and differential under-enumeration throughout the years, however, the exact rate of increase for this population cannot be estimated. There is, nevertheless, sufficient evidence that its number has increased rapidly. Such increase could not have been generated by the observed low birth rates in face of a rather high mortality rate in the range of 20 to 30 per 1000 (Latulippe-Sakamoto, 1971) and of some inevitable loss through assimilation. There is no plausible basis whatsoever for such jumps in birth-rate as those of 28 to 60 per 1000, shown by the official series on the census Indian population. Finally, though some differences in birth-rate between registered Indians and census Indians might be expected, the discrepancy actually observed, 48 and 60 per 1000 respectively for 1961, is highly suspicious and casts serious doubts about the validity of the underlying statistics.

The space allotted to this paper does not allow a detailed discussion of the possible sources of biases affecting the official birth-rate series. The existence of these biases are sufficiently demonstrated by this brief review to justify alternative ways of estimating birth-rate to be undertaken in the present paper. It suffices to mention here a few possible sources of biases. The low birth-rate observed for the earlier years, actually to a larger or lesser extent throughout all the period prior to 1960, is no doubt indicative of considerable birth under-registration.

Biases from other sources have beset the official statistics too, and make the interpretation of the observed trends hazardous. Since the conventionally calculated birth rate involves two quantities, births in the numerator and the midyear population in the denominator, one can suspect more or less considerable inconsistencies between these two quantities, due either to differential underreporting or to differences in the definition of Indians. The inconsistency of the latter type can be demonstrated when one considers changes in the census method of tracing origin of Indians. In censuses prior to 1941 the ethnic origin was traced through the mother, and persons who had Indian mothers were classified as Indians. The 1941 census makes an explicit distinction between Indians and those of mixed origin. In subsequent censuses, Indian origin, like the origin of other ethnic groups, was traced through the father. This rule, however, was applied only to persons living off reserves; those living on reserves were classified as "native Indians" if either the father or mother was Indian.

Views may be held that to achieve some improvement in the estimates one may choose to make proper adjustment of differential under-reportings coupled with corrections for definitional inconsistencies in the official series.

The above reference to the kind of biases involved suffices to discourage any undertaking in this direction. It would be an extremely painstaking process and its feasibility is subject to grievous doubts. Instead these writers have preferred a less conventional but, in their view, a more promising approach by estimating birth-rate through techniques using stable population models. This approach is the subject of the following two sections.

DERIVATION OF BIRTH-RATE FROM AGE DISTRIBUTION

It is well known that the age distribution of a population closed to migration is determined by past fertility and mortality. Moreover, the age distribution of such a population will tend to become stable if, for many years, it is subjected to a regime of constant mortality and fertility. The relationship between age distribution and vital rates of a stable population is implied in the equation:

$$c_x = b e^{-rx} L_x/l_0$$

where c_x is the proportion at age x , b the birth-rate, L_x/l_0 the proportion surviving from birth to age x , r the rate of population increase, and e the base of the common logarithm.

Considerable simplification can be achieved if stable population models are used rather than the procedures implying the above-mentioned equation. Coale and Demeny stable population models (1966) are among the best known and will be used for the present estimates. There are four families of Coale-Demeny models – West, East, North, and South – named so after the countries from whose life tables they have been derived. Each family thus constituted is “homogeneous” with respect to the age pattern of mortality. Family West, for example, is constituted of models based on the life tables for countries of Western Europe, United States, Australia, New Zealand and Canada. Within each family models are ordered according to the level of mortality as measured by the expectation of life at birth, infant mortality rate, or by some other life table function.

The Indian population does not fully meet all the prerequisites of stability, but it is plausible to argue that until recent years it has not deviated seriously from a stable form. It is a fair assumption, corroborated by empirical evidence to be produced later in this paper, that fertility has remained at its high level in the past. Like many other similar populations, Indians are unlikely to have practised birth limitation to any significant extent. This at least has been confirmed by a recent intensive demographic survey undertaken by these authors in the James Bay area. Only for the last decade has there been evidence of a substantial downward shift in fertility.

The decline in mortality started earlier, but it was probably gradual and until 1940, slow. Moreover, it has been amply demonstrated that mortality has relatively little effect on age distribution, and the relationship between fertility and age distributions implied in the above equation still holds,

though only approximately (J. A. Coale, 1963). Therefore, at least prior to 1960, the Indian population may rightly be viewed as a "quasi-stable,"² if not a stable one.

With regard to migration, there are flows from the reserves to the metropolitan areas, but there is no evidence that these are strongly age-selective. Some assimilation takes place with the Indians accepting the status of regular Canadian citizens or by intermarrying, but this is unlikely to be age-biased to the extent of destroying the normality of the age distribution, as implied in a quasi-stable population.³ The age pyramid based on the 1961 census, shown in Figure 1, displays all the regular features of a population characterized by the persistence of a relatively high fertility, and is apparently free from conspicuous distortions.

To make use of stable population models for the purpose of estimating birth-rates, the following are required: (i) the age distribution (proportion of individuals in a particular age group); (ii) an indication regarding the age pattern of mortality (to determine the family of the models); (iii) a measure of the level of mortality (to select for a family the proper model showing the relationship between age distribution and birth-rate). We shall now assess the validity of these elements.

Level and Age Pattern of Mortality

It is only since 1960 that, owing to the efforts of the Department of Indian Affairs, registration of deaths has become sufficiently accurate for reliable use. That year also marked the beginning of the calculation of mortality rates by sex and age groups and the construction of life tables. According to these life tables expectation of life at birth is approximately 62 years and the most recent infant mortality rates are about 60 per 1000 births.

Mortality data for Indians have been collected, with interruptions, back to 1900, but these data, to the period prior to 1960, can only be used to calculate the crude death-rate, and for some periods, the infant mortality rate. The death-rates suffer from basically the same defects as conventionally calculated birth-rates, notably, inconsistency between the numerator (deaths) and the denominator (population, or births in the case of the infant mortality rate). There is evidence of under-reporting in the earlier years, although, in view of the legal obligation to report deaths, it is likely that registration of deaths was less incomplete than births.

After careful examination for trends and levels, and after adjustments to make the numerator (deaths) and the denominator (total population) more consistent, a series of death-rates were computed. They seemed reasonably high so as to be quite acceptable for two particular periods, 1940-60 and 1911-17. Rates for the intermediate years (1918-39) were obtained by interpolation and for the years from 1911 back to 1900 by extrapolation of

2 The term quasi-stable applies to those populations which experience a changing (actually a declining) mortality while keeping unchanged their fertility rate.

3 For example, there were only 714 cases of enfranchisement of Indians in 1969.

PYRAMID OF AGE DISTRIBUTION FOR THE INDIAN POPULATION IN PER CENT
 (BASED ON THE 1961 CENSUS)

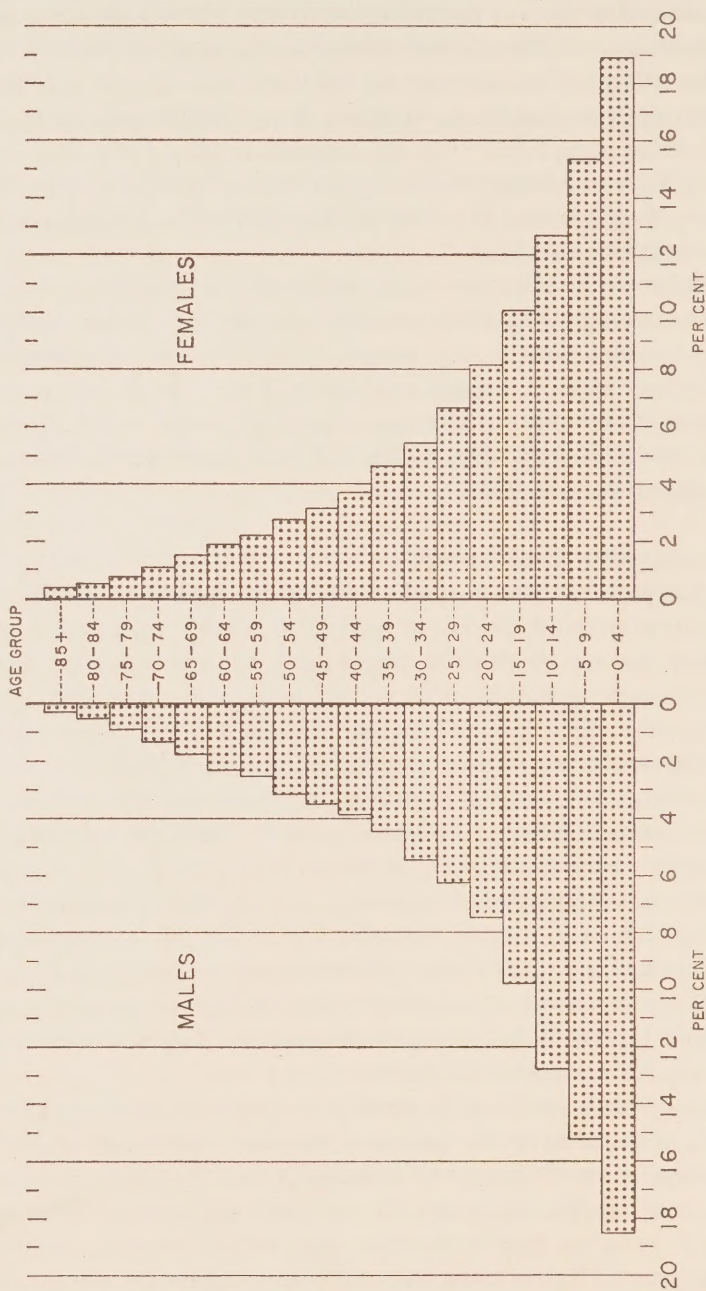


FIGURE I

the trend. (For more details see Latulippe and Sakamoto, 1971.) Infant mortality rates ${}_1q_0$, were used for the selection of the stable population models to derive birth-rate estimates. For the years for which ${}_1q_0$ is not given, it was derived from the crude death-rate by means of stable population models taking into account the age structure. The official mortality series from 1960 on seemed to be reliable and were used as such.

According to those estimates ${}_1q_0$ decreased first very slowly, from a high of about 235 infant deaths for 1000 births at the beginning of the century, to about 200 around 1940. It then fell with increasing speed to reach about 60 per 1000 in 1968.

The remaining point to be elucidated is the age pattern of mortality. This is instrumental in determining the family of stable populations to which the Indian population is likely to pertain. As mentioned at the outset of this section, trustworthy data on deaths by age have been available only since 1960, and, accordingly, we can refer here only to this recent period. Analysis by means of the ratio between mortality for relevant age segments revealed that the Indian age pattern of mortality comes closer to the Western family than to any other known family, East, North, or South. Two additional reasons may be cited in favour of choosing the Western family. One is that Canadian mortality pertains to the Western family, and it can be surmised too that Indians, who have been exposed to similar health conditions at least during more recent years, have morbidity and mortality patterns similar to the whole of Canada's population. The other reason is that the Western family of life tables covers a range of experience much wider than the three other families and, therefore, is more likely to encompass the Indian experience as well.

Age Distribution

There are two series of data on age distribution. One was developed by the Department of Indian Affairs for registered Indians and goes back to 1900. The other pertains to population of Indian origin and is based on the censuses of 1921, 1931, 1941, 1951, and 1961.

The series published by Indian Affairs include such age breakdowns as under six and six to 15 (inclusive) for earlier periods, and under seven and seven to 16 (inclusive) for later periods. To ensure comparability, proportions for these age breakdowns were adjusted to obtain standard five-year age-groups. The adjustment was achieved with the help of stable population models implying a gross reproduction rate of 3.3⁴ and an expectation of life of 32.5. The latter figure, which probably reflects mortality of earlier years, was kept constant for the sake of speedy calculation. However, assumptions which imply a decreasing mortality would not have seriously affected the adjustment factor used. No such corrections of age distribution were required for registered Indians from 1960 on, and, for census years, for persons of Indian origin. These are given in standard form.

4 This rate is consistent with the estimates of birth rates.

Under the assumptions of perfect stability (providing that the underlying data are equally reliable) it does not matter which age segment is used for deriving the birth rate. Where changes in fertility might be suspected it is advisable to make use of the proportions in infant ages, since they are more sensitive to the variations in fertility. The birth-rates derived from them are likely to reflect the natality that has prevailed during the few years prior to the years for which the age distribution is available. Proportions in infant age groups to be used for deriving the birth-rate are contained in Tables I and II and portrayed in Figure II.

Inspection of Tables I and II and of Figure II gives rise to a number of observations. Firstly, there is a rather sharp increase in childhood proportions, especially during the fifties, a trend that can be attributed both to better enumeration, or age classification, of infants, and to falling mortality. An obvious indication of under-reporting of infants, or their misclassification for earlier years, is revealed by the analyses of census data. According to 1921 census figures, the proportion under age five is less than the proportion in the five to nine age-group. Under-reporting may also be suspected for the 1931 and even the 1941 censuses, because the excess of the zero to four group over the five to nine group is smaller than would normally be expected. Age distortions due to differential under-reporting or misclassification are detected also in the earlier returns of population registration by Indian Affairs. But the pattern of these distortions is somewhat different. For reasons that remain unclear the deficit seems to be larger in higher than in lower infant ages. Thus, after a careful analysis through stable population models, we have uncovered that the percentage in age-group five to 14 is underestimated as compared with the percentage in age-group zero to four by some two or three points.

Secondly, there are, for the earlier years, inconsistencies between the proportions based on the census and those provided by Indian Affairs, an indication that either the census, registration, or both have faults. By contrast, the disagreement is small for 1961 and this can in itself be interpreted as an indication of improvement in both enumeration and registration as well as in age reporting of Indians in recent years. One would not expect complete agreement between the two sources, for, while the census covers Indians of ethnic origin, the Department of Indian Affairs records only those legally defined as Indians.

A final observation concerns the downward trend in the proportion under five since 1960. This, along with the evidence produced by the birth-rate calculated directly from data supplied by Indian Affairs, and considered as reliable for this period, seems to indicate a fertility decline (see Table VII). Hence, the assumptions of stability or quasi-stability made throughout this paper no longer hold after 1960. Nonetheless, if confined to the proportion under five, which is very sensitive to fertility changes, worthy estimates of birth-rates can be obtained and matched with the directly calculated birth-rates for 1960 onward. We shall return to this latter point in another section.

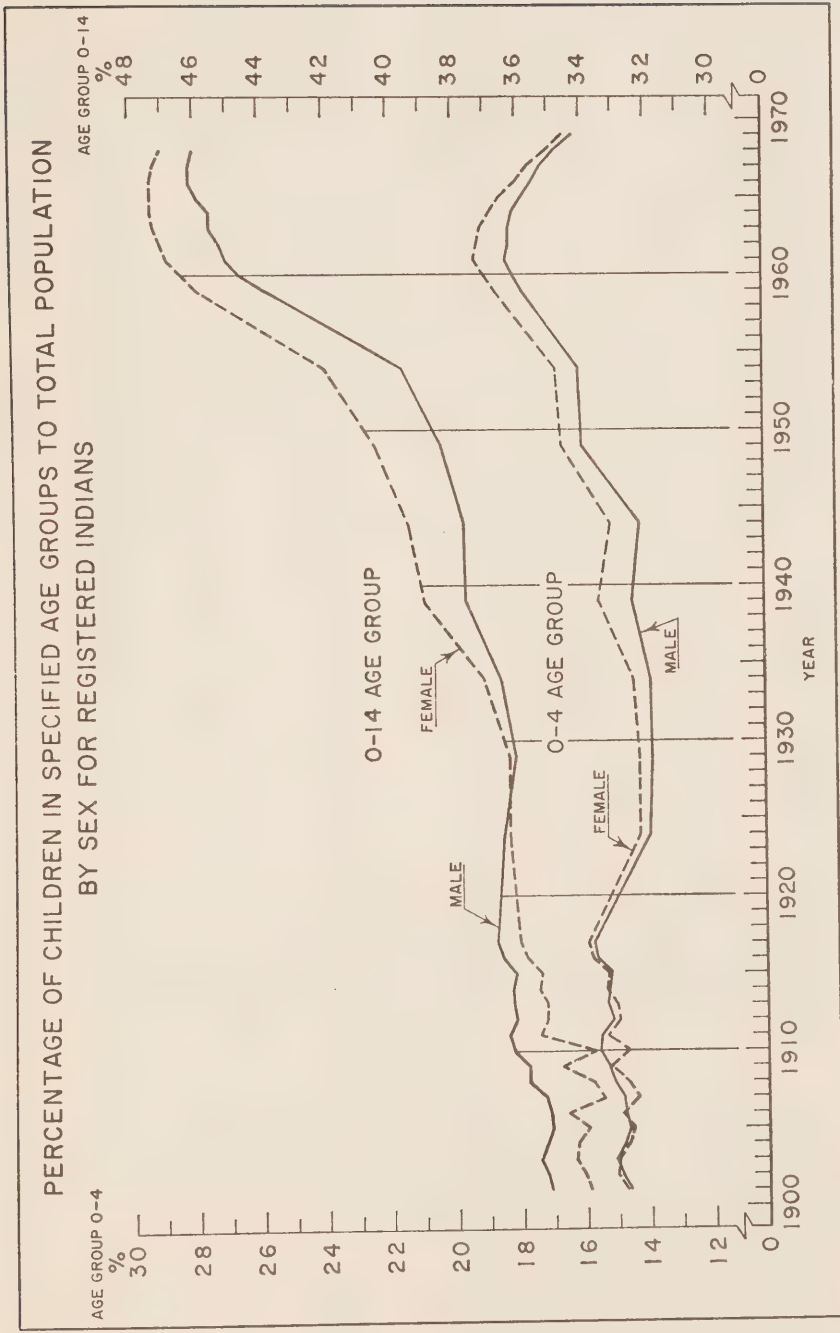


FIGURE II

TABLE I

PERCENTAGE OF CHILDREN IN SPECIFIED AGE GROUPS TO TOTAL POPULATION
BY SEX FOR REGISTERED INDIANS

Year	Males			Females		
	0-4	5-9	0-14	0-4	5-9	0-14
1901	14.63	—	35.11	14.68	—	33.89
1902	14.93	—	35.22	15.03	—	34.07
1903	15.05	—	35.44	15.02	—	34.35
1904	14.77	—	35.23	14.68	—	34.27
1905	14.65	—	35.06	14.53	—	33.95
1906	14.79	—	35.10	14.83	—	34.56
1907	14.85	—	35.28	14.35	—	33.45
1908	15.12	—	35.78	14.69	—	33.74
1909	15.27	—	35.78	15.26	—	34.76
1910	15.56	—	36.25	14.67	—	33.69
1911	15.52	—	36.40	15.33	—	35.40
1912	15.13	—	36.14	14.94	—	35.19
1913	15.31	—	36.24	15.02	—	35.18
1914	15.24	—	36.25	15.26	—	35.41
1915	15.18	—	36.14	15.21	—	35.36
1916	15.62	—	36.55	15.74	—	35.80
1917	15.73	—	36.72	15.88	—	36.01
1924	13.96	—	36.48	14.22	—	36.29
1929	13.87	—	36.10	14.22	—	36.29
1934	13.88	—	36.53	14.41	—	37.07
1939	14.41	—	37.62	15.47	—	38.90
1944	14.17	—	37.63	15.08	—	39.37
1949	15.98	—	38.36	16.59	—	40.38
1954	16.03	—	39.55	16.78	—	41.94
1959	17.79	—	43.84	18.64	—	45.85
1960	18.1	14.2	44.1	19.0	14.8	46.3
1961	18.3	14.4	44.5	19.3	15.1	46.8
1962	18.2	14.8	44.7	19.2	15.5	47.0
1963	18.2	15.0	45.0	19.1	15.7	47.2
1964	18.1	15.2	45.2	18.8	16.0	47.3
1965	17.8	15.4	45.2	18.5	16.3	47.3
1966	17.5	15.7	45.4	18.0	16.5	47.3
1967	17.2	15.7	45.5	17.6	16.5	47.2
1968	16.8	15.8	45.4	17.0	16.6	47.0
1969	16.2	16.0	45.4	16.5	16.6	46.8

SOURCE: Annual reports of the Department of Indian Affairs.

NOTE: Prior to 1960 proportions have been adjusted to bring them to standard age groups, as presented in this table. No such adjustment was required after that year. Proportion 5-9 age-group could not be calculated from available data prior to 1960.

Discussion of Estimates Derived by Stable Population Models

Once the infant mortality rate, as a measure of mortality level, and the family of models (in this case, West) has been located with age pattern analysis, and the relevant proportions of age-groups assessed for their validity, the derivation of the birth rate is a trivial operation. It is readily given by the selected model. Some interpolation is necessary, for models do not cover all possible ranges of mortality experienced. Related estimates of birth-rate are presented in Tables III and IV.

Not all the estimates produced here warrant the same degree of confidence. As far as census series are concerned preference is given to estimates based

TABLE II

PERCENTAGE OF CHILDREN IN SPECIFIED AGE-GROUPS TO TOTAL POPULATION
BY SEX FOR THOSE OF INDIAN ORIGIN FOR CENSUS YEARS

Year	Males			Females		
	0-4	5-9	0-14	0-4	5-9	0-14
1921	13.4	14.0	39.6	14.1	14.5	40.5
1931	14.6	13.8	39.8	15.1	14.7	41.7
1941	14.1	13.3	39.0	15.5	14.1	41.6
1951	— ¹	— ¹	42.1	— ¹	— ¹	44.0
1961	18.5	15.3	46.5	18.9	15.4	47.0

SOURCE: Unpublished tables made available by Dominion Bureau of Statistics (Census Division).

1 Not available by 5-year age-group.

TABLE III

BIRTH-RATE PER 1000 DERIVED FROM PROPORTIONS IN
SPECIFIED AGE-GROUPS FOR REGISTERED INDIANS, 1901-69

Year	0-4			0-14		
	M	F	(M + F)/2	M	F	(M + F)/2
1901	41.8	41.4	41.6	37.6	35.3	36.5
1902	43.0	42.2	42.6	37.8	35.5	36.7
1903	43.3	42.2	42.8	38.1	35.9	37.0
1904	42.4	41.4	41.9	37.8	35.8	36.8
1905	42.2	40.6	41.4	37.6	35.5	36.6
1906	42.4	41.6	42.0	37.6	36.3	37.0
1907	42.5	40.2	41.4	37.8	34.7	36.3
1908	43.6	41.4	42.5	38.7	35.1	36.9
1909	43.9	42.8	43.4	38.7	36.4	37.5
1910	45.0	41.4	43.2	39.3	35.1	37.2
1911	44.3	43.0	40.7	39.0	37.3	34.0
1912	43.6	42.2	42.9	38.8	37.1	38.0
1913	43.9	42.2	43.1	38.9	37.1	38.0
1914	43.9	42.8	43.4	38.9	37.3	38.1
1915	43.8	42.8	43.3	38.8	37.3	38.1
1916	45.0	45.0	45.0	39.7	37.9	38.8
1917	45.1	44.6	44.9	40.0	38.1	39.6
1924	40.0	39.6	39.8	39.5	38.5	39.0
1929	39.8	39.6	39.7	38.5	38.4	38.5
1934	38.6	38.9	38.7	38.1	39.1	38.6
1939	40.1	41.2	40.6	40.0	40.7	40.4
1944	37.4	39.6	38.5	37.5	40.4	39.0
1949	40.8	42.2	41.5	37.1	43.4	40.3
1954	39.5	41.2	40.4	37.4	40.3	38.9
1959	38.6	45.5	42.1	41.8	43.7	42.8
1960	43.8	45.4	44.6	41.8	44.0	42.9
1961	44.0	45.9	45.0	42.0	44.4	43.2
1962	44.0	45.5	44.8	42.3	44.6	43.5
1963	43.8	45.2	44.5	42.7	45.0	43.9
1964	43.4	43.8	43.6	42.8	43.8	43.3
1965	42.2	42.9	42.7	42.4	44.4	43.4
1966	41.4	41.5	41.4	42.8	44.4	43.6
1967	40.4	40.9	40.7	42.6	44.0	43.3
1968	39.1	39.0	39.1	42.7	43.8	43.3
1969	37.7	37.9	37.8	42.1	43.6	42.9

NOTE: See Table I for sources and the text for method of calculation.

TABLE IV

BIRTH-RATE PER 1000 DERIVED FROM PROPORTIONS IN SPECIFIED AGE GROUPS
FOR THOSE OF INDIAN ORIGIN FOR CENSUS YEARS

Year of census	0-4			5-9			0-14		
	M	F	(M + F)/2	M	F	(M + F)/2	M	F	(M + F)/2
1921	37.7	39.4	38.6	48.1	53.4	50.8	44.3	45.4	44.9
1931	41.2	42.0	41.6	48.9	52.5	50.7	44.1	45.4	44.8
1941	38.4	41.8	40.1	44.5	47.9	46.2	41.1	44.6	42.9
1951	—	—	—	—	—	—	41.6	44.2	42.9
1961	44.6	47.1	45.9	45.1	46.8	46.0	45.6	44.3	45.0

NOTE: See Table II for sources and the text for method of calculation.

on the proportion five to nine, as it was argued, there is evidence of a more complete enumeration for this group than for those under five. Only for the 1961 census is differential under-enumeration no longer evident. For registered Indians the proportion under age five, in contrast to the census, appeared to be more reliable for earlier years. The estimates based on the proportion under five are therefore recommended. This is particularly true for the years after 1960, in view of fertility decline in evidence since that year. We shall return to this point later.

It must be stressed that our attempts have been to obtain the best possible estimate of the level of birth-rates for a population for which, on account of the inadequacy of the data, the conventional method of measuring reproductive performance has failed. No claims on exactness of these estimates can be made, which is clear from the lengthy discussion of the reliability of the age distribution data and of the parameters used for estimation. Yet, by way of concluding this section, a brief presentation of the specific sources of possible errors affecting the estimates will be given to elucidate the nature and, possibly, the magnitude of the errors involved.

Firstly, there is uncertainty about the exact level of mortality. We may argue, however, that mortality has only a secondary effect on the age distribution and that a given error in the mortality estimate will entail a proportionately smaller error in the estimates of birth-rate derived from the age distribution. Secondly, there is uncertainty as to which particular family of stable population the Indian population actually does pertain. The model West has been selected on the basis of data for recent years and these may not reflect adequately the age pattern of mortality for earlier periods. A model from another family, say, East or North, would generate a somewhat different result. The difference depends, however, on the estimators that are associated with the operation. When the proportion in childhood (particularly under age five) is combined with infant mortality, as in this case, all four families will yield very similar results (Romaniuk, 1967).

Thirdly, mortality has declined and, since World War II, apparently rapidly. This in itself is a cause of distortion. However, changes in mortality, when gradual, are unlikely to cause great errors in the estimates by stable

population techniques. Corrections for the destabilization process due to the decline of mortality are feasible (Demeny, 1966), but the amount of work involved and the uncertainties about the pace of the decline would hardly warrant the few improvements gained in the estimates. It suffices to mention that the effect of no correction for the mortality decline would be a slight upward bias in the birth-rate derived from the proportion under age five.

Fourthly, there is clearcut evidence of fertility dropping gradually since 1960. The ensuing process of destabilization is more powerful than the one previously mentioned. It has been demonstrated that birth-rate estimates derived from age distribution destabilized by a declining fertility will be upwardly biased, to an extent that will depend on the pace and duration of decline, and the age proportion being used (Romaniuk, 1967). The bias will be very small when using, as in this case, the proportion under age five. Coale and Demeny have worked out procedures for adjusting biases generated by the type of destabilization discussed here (United Nations, 1967). Instead of resorting to these procedures (and probably with the same success), the birth-rate derived from the proportion under age five since 1960 has been lagged by 2.5 years so that they correspond to the years in which, on the average, children aged zero to four were born. The resulting birth rates are presented in Table VII and discussed in one of the next sections.

BIRTH-RATE DERIVED FROM MEAN NUMBER OF CHILDREN EVER-BORN TO EVER-MARRIED WOMEN

In a situation where direct evidence relating to birth-rates is so dubious, due attention should be given to all available pieces of information from which inferences concerning fertility could be drawn. After having made use of age distribution, in the previous section, we shall now take advantage of the availability of particular information provided by 1961 census data: *the mean number of children ever-born to ever-married women*, in Table V, and convert it into a birth-rate.

The conversion of the children ever-born into a birth-rate has been achieved through the stable population models showing the relationship between birth-rate and gross reproduction rate. In order to perform the operation we had to proceed through a number of steps and secure additional information.

Firstly, the mean number of children ever-born had to be calculated for women of all matrimonial status. This was done as shown in columns 3 and 4 of Table V, by multiplying the mean number of children ever-born to ever-married women by the proportion of ever-married women in respective age-groups. Since the 1961 census does not provide proportions of women ever-married these are taken from the 1951 census. Whether these proportions reflect exactly the nuptiality of the relevant cohorts of women is an open question. It may, however, be a fair assumption that nuptiality has not varied prior to 1951 to such an extent as to affect seriously the results of the opera-

TABLE V

AVERAGE NUMBER OF CHILDREN EVER-BORN BY AGE OF WOMEN,
DERIVED FROM 1961 CENSUS

<i>Age</i> (1)	<i>Average number of births per ever-married woman (1961 census)</i> (2)	<i>Women ever-married as percentage of all women (1951 census)</i> (3)	<i>Estimated average number of births per woman (all women irrespective of matrimonial status) (2 x 3) (4)</i>
15-19	1.262	15.8	0.202
20-24	2.267	59.7	1.360
25-29	3.786	79.0	2.999
30-34	5.106	90.0	4.595
35-39	6.259	94.0	5.883
40-44	6.761	95.0	6.423
45-49	6.702	96.0	6.434
50-54	6.131	96.0	5.886
55-59	6.013	96.0	5.772
60-64	6.009	96.0	5.769
65+	5.804	96.0	5.572

SOURCES: Col. (2): Dominion Bureau of Statistics, 1961 census, Volume 4.1, Bulletin 4.1-8. Col. (3): unpublished data from Census Division, Dominion Bureau of Statistics.

tion. Only about four per cent of the women who had passed fertile life remained single. Implicit in this operation is the assumption that none of the spinsters had given birth to any child.

Secondly, the model implies a relationship between the birth-rate and the gross reproduction rate, which by definition refers to female birth only. In order to derive the birth-rate from the mean number of children ever-born, by means of the model, it is necessary to convert the mean number of children ever-born into the gross reproduction rate. Such a procedure requires the knowledge of the masculinity rate or of the proportion of girls at birth. On the basis of the data for the last decade the latter proportion has been estimated at 0.49.

Thirdly, the use of the model requires the knowledge of the mean age at maternity. This is obtained from the age specific fertility rates weighted by the age of the mother at delivery. According to available data, the mean age at maternity has varied from 29.6 for 1931 to 28.2 for 1968.

The derived birth-rate is shown in Table VI. It is evident that only the proportion of children ever-born to those who have passed or are about to reach the end of childbearing could be used for estimating the birth-rate. On the other hand, there is indication of omission of children as women become older, so that less confidence can be placed in birth-rates derived from the proportion of children for elderly women. The least biased birth-rate estimate is probably the one referring to women in age group 45-49, which amounts to 44 per 1000. But even this figure is likely to be an understatement, because some of the women included in this age group may still have children, and because, in converting the proportion of children ever-born for ever-

TABLE VI

BIRTH-RATE DERIVED FROM AVERAGE NUMBER OF
CHILDREN EVER-BORN ESTIMATED IN TABLE V

<i>Age of mother</i>	<i>Average number of children per woman</i>	<i>Corresponding birth rate</i>
45-49	6.43	43.9
50-54	5.89	41.5
55-59	5.77	40.3
60-64	5.77	40.3

married women into proportion for all women, the fertility of those remaining single has implicitly been assumed to be nil. Yet at least some of those four per cent who remained single have had children. Hence, it is plausible to argue that the actual birth-rate is somewhat above 44, all other things being equal.

There is no way to relate this rate to any particular period unless some strong assumption is made, such as that women age 45-49 at the census date (1961) had given birth to all their children while 28 years old (mean age at maternity). In this case one may relate this birth-rate to the years centred on 1942. Note that the birth-rate derived from the age distribution for this year is 46 per 1000.

Birth Rates since 1960

The trends that have developed since about 1960 are of such importance for a study of the dynamics of Indian population in this country that especial attention should be given to the birth-rates observed during the sixties. Table VII brings together the relevant information. In column 2 the birth-rates based on the annual number of births and the mid-year total population for registered Indians, provided by the Department of Indian Affairs and Northern Development, are presented. In recent years this department has achieved considerable progress in methods of collecting population statistics and it can be said that the birth-rate series calculated since 1960 may be accepted with reasonable confidence.

The main source of errors that still continues to beset the official birth series is to be found in the late reporting. A careful study by Piché and George (1970), has revealed that some births are reported for registration with delays as long as one or two years, and even more. Furthermore, there seems to be variation from one year to another in the magnitude of the late reporting, a circumstance that is likely to affect adversely the level and the variation of the birth-rate. The series presented in column 2 has been adjusted for late reporting by the authors just referred to.

Column 3 exhibits the birth-rate derived from the proportion under age five by the stable population techniques described in one of the preceding sections. Column 4 shows the birth-rate derived from the proportion under age five adjusted for "late birth reporting effect." (For the method of adjustment see Piché and George, 1970.) Finally, column 5 contains the birth-rate

TABLE VII
OBSERVED AND ESTIMATED BIRTH-RATES, 1960-9

Year (1)	Based on registered births and adjusted for late birth reporting (2)	Derived by stable population models from proportion under age 5		
		Not adjusted (3)	Adjusted for late birth reporting (4)	Interpolate rates (5)
1960	46.1	44.6	45.9	46.0
1961	46.2	45.0	46.1	45.8
1962	44.6	44.8	46.1	45.0
1963	44.1	44.5	45.9	44.2
1964	42.7	43.6	45.0	42.8
1965	43.5	42.7	44.4	41.0
1966	41.2	41.4	43.3	39.6
1967	39.5	40.7	41.9	—
1968	38.4	39.1	39.9	—
1969	36.8*	37.7	38.5*	—

NOTE: The proportion in 0-4 age-group, from which birth-rates in column 4 are derived, have been adjusted for late reporting of births in similar manner as has been done to birth-rate in col. 2. For the method of adjustment see Piché and George, 1970. Values in col. 5 have been interpolated from rates in col. 4 to correspond to the years in col. 1.

*Adjustment for late birth reporting for 1969 is based on the proportion of late birth reporting estimated for 1968.

adjusted for 2.5 years time lag. This adjustment was necessary since the proportion of age under five reflects the fertility not for the year to which it refers, but for a period of five years prior to that year. In other words there is a time lag of 2.5 years, on the average, between the year to which the proportion under age five refers and the birth-rate derived from this proportion.

Whether we look at direct evidence – official birth-rate series adjusted for late reporting – or at indirect evidence – birth-rates derived from proportion under age five – the picture conveyed is that of a precipitous decline in natality. The birth-rate has fallen from 46.2 in 1961 to 36.8 per 1000 in 1969, a reduction of 20 per cent in eight years, according to the official series. Decline of a similar magnitude is borne out by the series based on proportion under age five. The fact that two independent sets of estimates agree so closely, both in the level and the trend, lends considerable credibility to the underlying data and leads to the conclusion that the movement of the decline is not a spurious but a real one.⁵ Yet one cannot say with certainty, at this stage of research that the movement is a reflection of a durable process of fertility

5 One structural factor which one could think of as having a depressing effect on the birth rate would be a process of selective assimilation affecting Indian females in reproductive ages. However, to generate such a rapid reduction in the birth-rate as that observed since 1960 the process would have to affect a very considerable proportion of females of childbearing ages, and this, as indicated elsewhere in this paper, does not appear to have taken place in the light of the age distribution series. Evidence of fertility decrease is also found in the series on age specific fertility rates, which for lack of space could not be examined here. It suffices to mention that, with the exception of the 15 to 19 age-group, fertility has decreased in all age-groups.

reduction or that it follows a pattern of decline that Western nations experienced in much earlier days. Extensive research into the procreative behaviour of Indians would be necessary for fuller disclosure of the significance of the changes in the birth-rate under way. One needs to take a careful look at the differential fertility by age and by cohorts, as well as at the differential fertility among the various Indian sub-groups, stratified according to the degree of "westernization" to which they are being subjected. Of course the investigation would have to include also numerous social, economic and biological factors affecting reproductive patterns. Such, however, is not the scope of the present paper.

CONCLUDING COMMENTS

As a result of the analysis undertaken in this paper we obtained a set of improved, but still relatively disparate, estimates of the birth-rate. To provide the reader with a simpler picture of natality levels and trends a selection of what we believe, in the light of the foregoing analysis, to be the most plausible estimates of birth-rate is presented in Table VIII and Figure III. For the period prior to 1960, in view of the uncertainty that still exists as to the reliability of the underlying data, we elected to retain two series, one providing a lower, the other an upper limit to the birth-rate. The former is based on the proportion of infants under age five from the Department of Indian Affairs, the latter on the age five to nine proportion from the census data. For the years 1960 to 1969, the rates are based on birth and population registration data from the Department of Indian Affairs and Northern Development, adjusted for late birth reporting.

Two distinct major periods seem to emerge in these series. The first period, 1900–60, seems to have been dominated by a relatively high natality. The two series convey, however, a contradictory picture as to the long-term trends: the lower suggests an increase, the upper a decline in fertility. Neither series, however, is of such unquestionable quality as to permit a definite conclusion in this respect. If any, long-term changes were probably slow.

The authors are inclined to believe that the actual birth-rate of the Indians for this period was closer to the upper (50) than to the lower (40 per 1000) series. At least two findings presented in this paper favour this option. One finding, based on the analysis of the 1961 census data concerning children ever-born to women in post fertile ages, suggests that the birth rate for the years around 1940 exceeded 44 per 1000. The other finding, based on the analysis of recent official birth statistics, considered as quite reliable, reveals a birth-rate of 46 per 1000 for 1960.

The second period, 1960–9, is that of steady reduction in the birth-rate. This fell from 46 in 1961 to 36.8 in 1969, a rather impressive reduction of more than two per cent annually. As mentioned earlier in this paper, it is not as yet clear whether the phenomenon is an *incipient* fertility decline that will continue until modern reproductive patterns are established, or is only a temporary phenomenon, the causes of which escape our immediate percep-

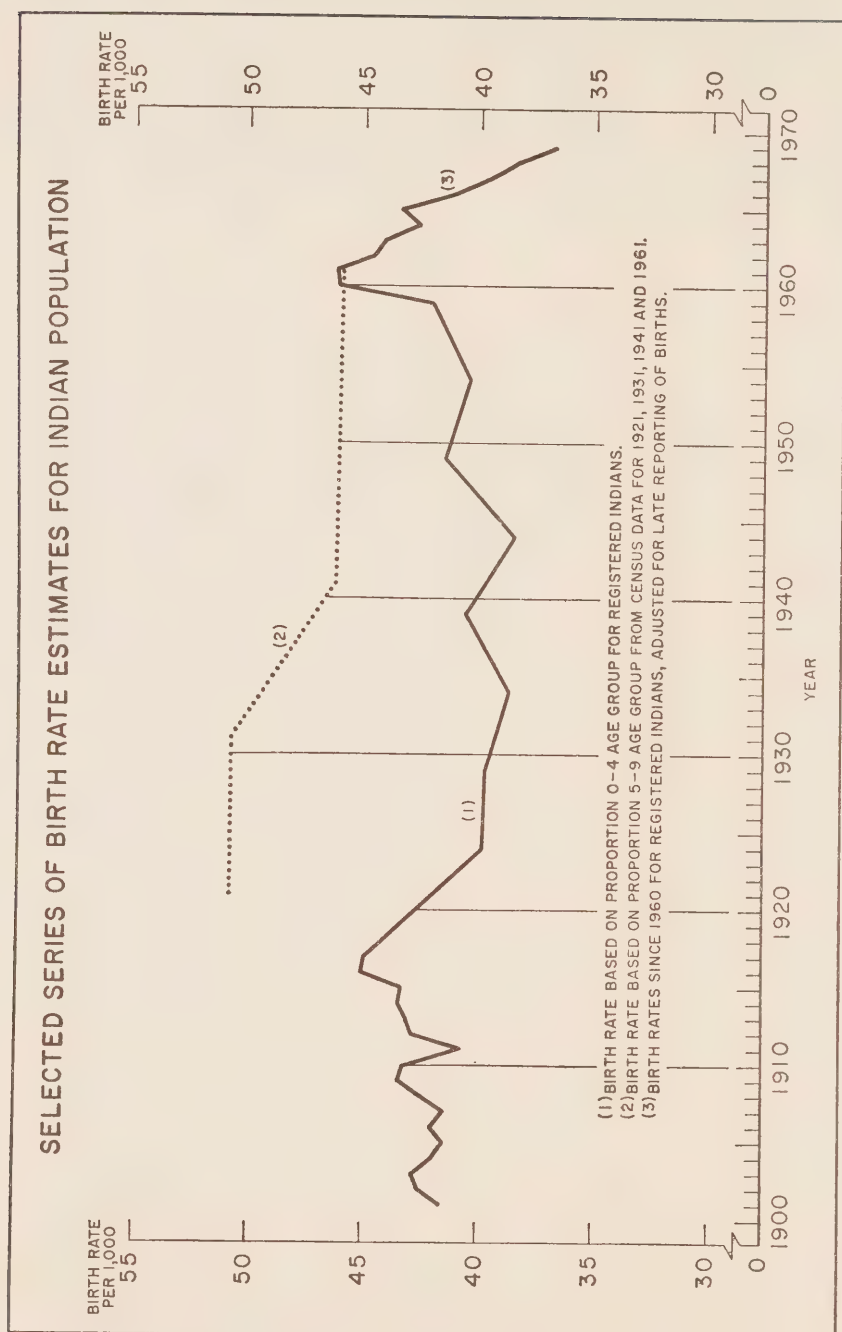


FIGURE III

TABLE VIII

SELECTED BIRTH-RATE SERIES FOR INDIAN
POPULATION IN CANADA, 1901-69

<i>Years</i>	<i>Registered Indians (Indian Affairs)</i>	<i>Those of Indian origin (census)</i>
1901	41.6	
1902	42.6	
1903	42.8	
1904	41.9	
1905	41.4	
1906	42.0	
1907	41.4	
1908	42.5	
1909	43.4	
1910	43.2	
1911	40.7	
1912	42.9	
1913	43.1	
1914	43.4	
1915	43.3	
1916	45.0	
1917	44.9	
1921	—	50.8
1924	39.8	
1929	39.7	
1931	—	50.7
1934	38.7	
1939	40.6	
1941	—	46.2
1944	38.5	
1949	41.5	
1951	—	
1954	40.4	
1959	42.1	
1960	46.1	
1961	46.2	46.0
1962	44.6	
1963	44.1	
1964	42.7	
1965	43.5	
1966	41.2	
1967	39.5	
1968	38.4	
1969	36.8	

NOTE: Birth-rates for registered Indians are those derived from proportion 0 to 4 age-group by stable population techniques for years prior to 1960, and those officially published by the Indian Affairs and adjusted for late birth reporting after 1960.

Birth-rates for persons of Indian origin are derived from proportion 5 to 9 age-group by stable population techniques.

tion. Fuller elucidation of the phenomenon would require systematic study of the various facets of procreative behaviour of the Indian population, a task that could not be undertaken here. No forecasting of fertility can be afforded unless factors which underlie the current natality decline are brought to light.

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